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Idylwilde Reservoir

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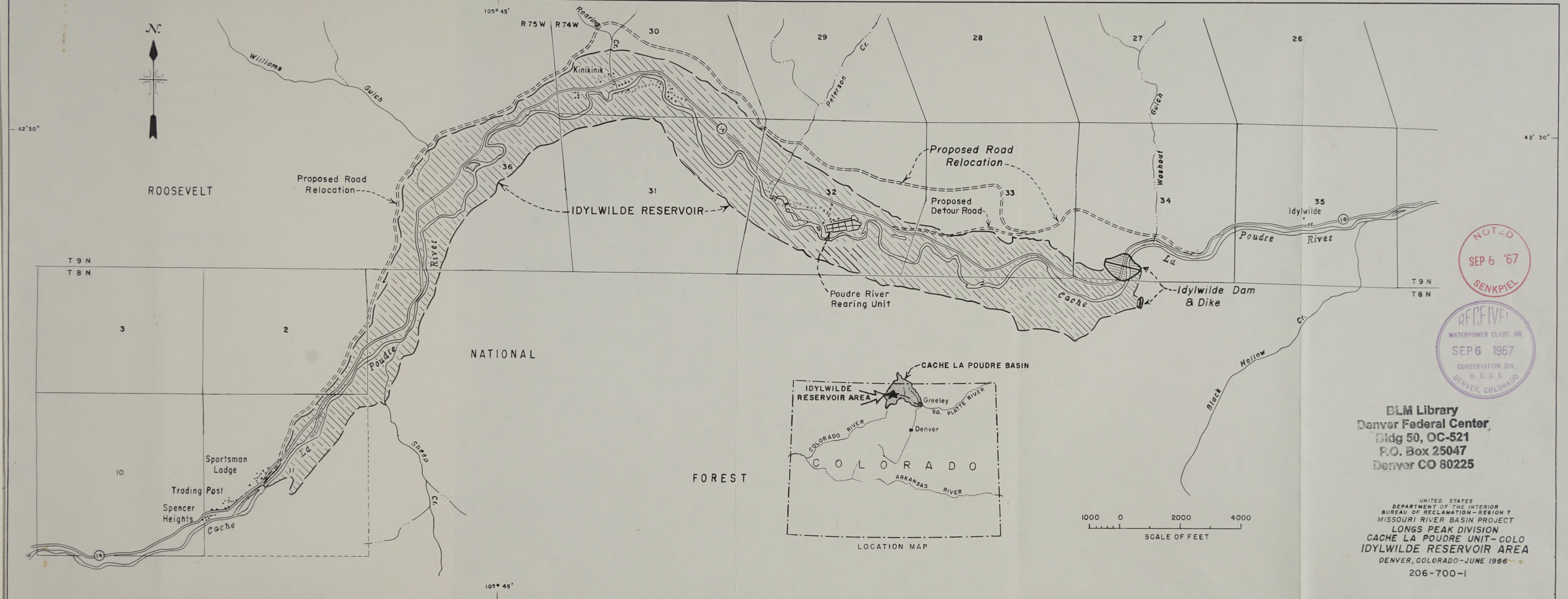

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION—REGION 7
MISSOURI RIVER BASIN PROJECT
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IDYLWILDE RESERVOIR AREA
DENVER, COLORADO—JUNE 1966
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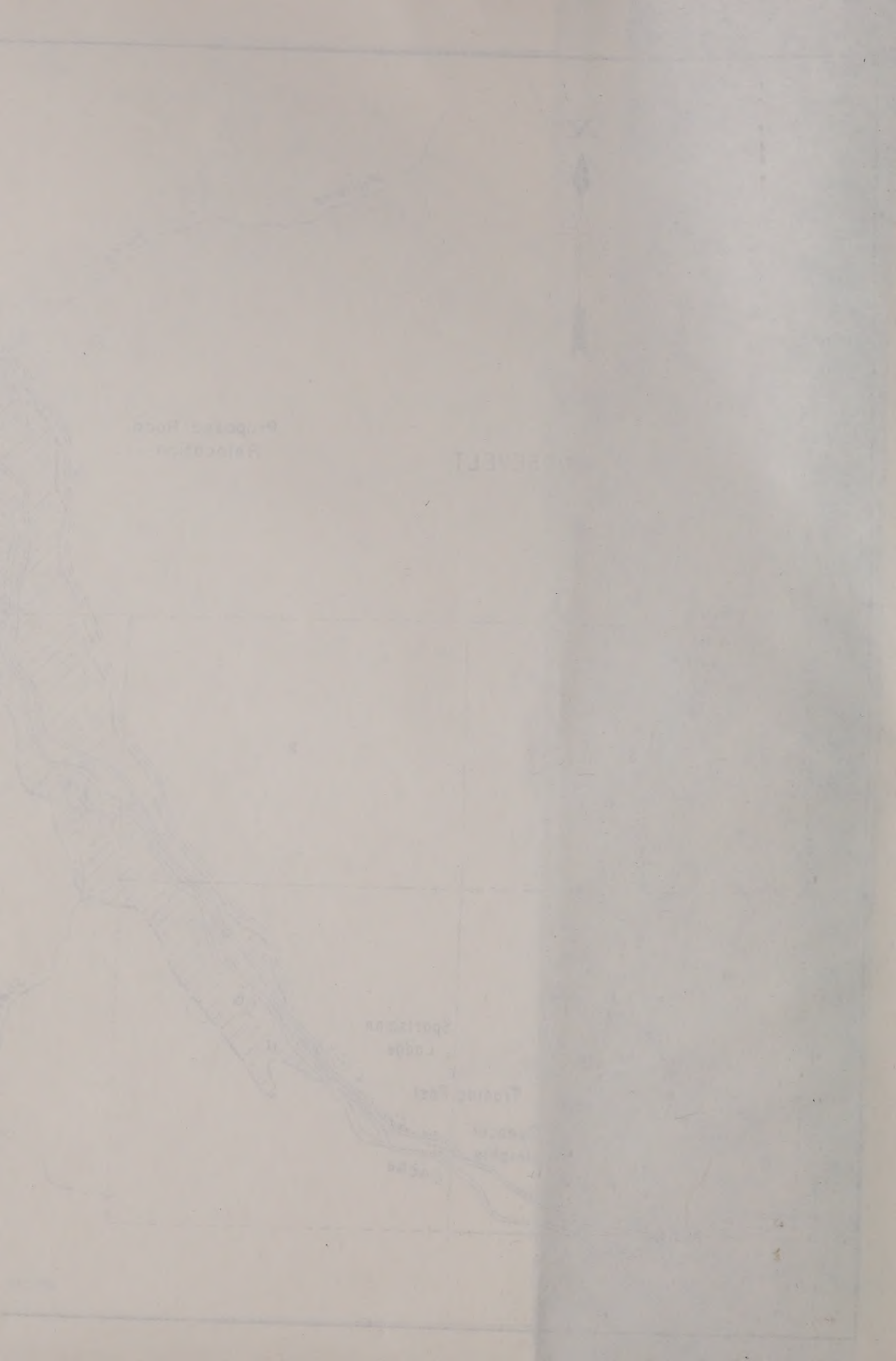

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CACHE LA POUDRE UNIT, COLORADO

Longs Peak Division

Missouri River Basin Project

CONCLUDING REPORT

July 1966

Bureau of Reclamation
Region 7, Denver, Colorado

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UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 7, DENVER, COLORADO

CONCLUDING REPORT
CACHE LA POUDRE UNIT, COLORADO

July 1966

PART I--INTRODUCTION AND SUMMARY

BACKGROUND

This concluding report summarizes the results and findings of uncompleted feasibility investigations on the Cache la Poudre Unit, Colorado.

A Reconnaissance Report dated February 1963 presented a comprehensive plan of development which included two storage dams and reservoirs, two hydroelectric powerplants, one power forebay, one power afterbay, one diversion dam, conduits, transmission lines, and substations. The principal function of that plan of development would have been the production of peaking power with one 24,000-kw. plant operating at a 20.4 percent load factor and a larger 250,000-kw. plant operating at a 7.2 percent load factor. Eighty percent of the project cost would be allocated to commercial power with the remainder of the costs allocated to the associated functions of municipal and industrial water supply, supplemental irrigation water supply, flood control, fish and wildlife, and recreation.

Although the reconnaissance plan appeared to hold promise of economic justification and financial feasibility, serious questions were raised concerning the market for the peaking power within the confines of Reclamation law and policy. Accordingly, approval for subsequent feasibility investigations was limited to a possible first-stage development consisting of the Idylwilde Dam and Reservoir only with minimum provisions to permit the possible future inclusion of power.

SUMMARY

Feasibility investigations of the Idylwilde Dam and Reservoir only, without power, were initiated in September 1963. The initial activities comprised engineering and hydrology studies. As these studies progressed it became apparent that further agricultural studies and land classification would not be required.

The reconnaissance report of February 1963 presented a complex plan which included combination of storage rights of Greeley's mountain reservoirs, regulation through exchange of city allotments from the Colorado-Big Thompson Project, abandonment of some plains irrigation reservoirs, and transfer of such plains storage rights to upstream Cache la Poudre Unit reservoirs. Enhancement of the available irrigation water supply would accrue through reduction of seepage losses from intake canals, addition to storage by provision of replacement capacity lost through sedimentation, and savings of water by reduction of evaporation.

As the studies proceeded, questions arose concerning: (1) whether supplemental irrigation water was urgently needed, and could be justified, and (2) the practicability of plains reservoir consolidation-transfer, and the willingness of their owners to participate. Numerous other problems were also encountered in attempting to devise procedures for practical application of the plains reservoir consolidation-transfer plans.

It was concluded that the total irrigated area in the Cache la Poudre basin had facilities and water supplies ample to meet an average of 95 percent of their theoretical requirements. The limited need for supplemental irrigation water probably could be met almost entirely by conservation measures and cooperative efforts of local interests.

Further analysis also was made of the municipal and industrial water supplies and requirements for Fort Collins and Greeley. The population projections made by the cities were utilized, although independent projections resulted in considerably lower estimates. Both cities have a policy of requiring new annexations to provide and assign rights for minimum supplies of water per acre of land. The analysis was based upon the population projections by the cities, a per capita requirement of 250 gallons of water daily, the full exercise of all presently owned water rights, and the new water rights accruing from the annexation policy. That analysis indicated that both cities would have adequate water until at least the year 2010 if the preceding basic assumptions are met. If their population projections should prove to be optimistic, the need for additional water would not arise for a longer period of time. The extent to which additional hold-over or regulatory storage might be needed was not studied in detail; however, either or both cities should be able to finance such improvements without hardship.

Although the probable adequacy of a future municipal and industrial water supply was a consideration, economics constituted the most important single element leading to the decision to terminate the investigations.

With the probability of elimination of most, if not all, of the irrigation function from the reservoir, most of the cost would necessarily have to be allocated to municipal and industrial water supply. The only other participating functions would be recreation and fish and wildlife enhancement. Public Law 89-72 limits the total allocation to no more than 50 percent of the reservoir cost to both of those functions. Although it is highly improbable that recreation-fish-wildlife benefits would support one-half of the cost, that assumption was made for analytical purposes. The remaining one-half of the cost would have to be repaid over a 50-year period at least at the rate of 3.222 percent. The resulting cost for 20,000 acre-feet from the Idylwilde Reservoir would average $30.47 per acre-foot annually. In lieu thereof, the cities can acquire allotments of water from the Colorado-Big Thompson Project at a price equivalent to about $11.25 per acre-foot of water annually at Horsetooth Reservoir.

The two factors (a) lack of a ready market for possibly 30 years, and (b) an available alternative at almost one-third of the probable cost of Idylwilde water, led to the decision in the fall of 1965 to terminate the investigations as soon as practicable. However, feasibility designs and cost estimates of the dam and reservoir were substantially completed for the record and for future reference if the investigations should be reactivated.

CACHE LA POUDRE STEERING COMMITTEE

The members of this committee represented local interests, except for one member each from the Colorado Water Conservation Board and the Bureau of Reclamation. The local interests were irrigation companies and the cities of Fort Collins and Greeley. The steering committee, which held monthly meetings, was instrumental in the collection of data, and endorsed various aspects of the investigation prior to their inclusion in the plan formulation studies.

PART II--GENERAL DESCRIPTION

The unit area is in northern Colorado, within the drainage basin of the Cache la Poudre River. The upper two-thirds of the basin is mountainous with the uppermost part lying along the Continental Divide. The higher peaks of the general area have elevations above 14,000 feet, and the streams are entrenched in narrow, steep-walled canyons and valleys. This mountainous area provides most of the water supply of the basin from native supplies and from transbasin importations. The basin slopes to the east and the mountainous sector merges into the Colorado Piedmont through which it extends to its confluence with the South Platte River. The Colorado Piedmont is a part of the Great Plains Region.

EXISTING WATER RESOURCE DEVELOPMENTS

Irrigation Facilities

Approximately 240,000 acres are irrigated within the Cache la Poudre River Basin. The water is distributed by 32 irrigation companies which operate and maintain the distribution systems and about 62 reservoirs of which 56 are located in the plains section and six are located in the mountainous section of the basin. The capacities of the storage reservoirs range from about 90 to 17,690 acre-feet; collectively, they have a total capacity of 161,300 acre-feet. Other irrigation facilities owned by the irrigation companies include diversion works, canals, and tunnels which convey water from the Colorado and North Platte River Basins into the Cache la Poudre Basin. There are five systems for making these transbasin diversions. All of these irrigation works were constructed prior to 1920.

The irrigated portion of the Cache la Poudre Basin is within the Northern Colorado Water Conservancy District, and is part of the primary service area of the Colorado-Big Thompson Project. Supplemental water from this project is delivered to the Cache la Poudre River near the point where it emerges from the mountains into the plains. Supplies from this source became available in 1953, and since then the area has reached a fairly high level of productivity.

During the past two decades considerable activity has been directed toward developing ground water for irrigation. In 1959, the United States Geological Survey reported that 1,100 operating irrigation wells were located in the basin. Additional wells have been constructed since 1959, but the number has not been determined.

Municipal and Industrial Water Facilities

The City of Greeley has developed canals and reservoirs in the mountains for collecting and storing M&I water supplies. The Columbine and Bob Creek ditches are transbasin diversions for this purpose. Six reservoirs have been constructed to assure adequate supplies during periods of low streamflow. Seaman Reservoir, with 8,700 acre-feet capacity, is the largest. The other five reservoirs owned by Greeley are considerably smaller, the average capacity of the five being approximately 1,500 acre-feet.

Both Greeley and Fort Collins own shares of the Colorado-Big Thompson Project, their holdings in 1965 being 13,125 and 10,250 shares, respectively. Supplies obtainable from these holdings constitute a substantial part of the total available M&I supplies. Further discussions of M&I supplies are presented in Part IV, "Hydrology".

PREVIOUS INVESTIGATIONS

In 1927 and 1928 the Bureau of Reclamation conducted investigations in the Cache la Poudre drainage basin. This was a cooperative undertaking with the Poudre Valley Water Conservation Association.

Several reservoir sites were investigated, water supplies were studied, and possible uses and requirements in the valley were analyzed. Estimates of cost for several reservoirs and hydroelectric plants were made.

A report entitled "Cache la Poudre Investigations, Colorado" was prepared in May 1928. It summarized the results of the studies but presented no conclusions or recommendations.

The irrigated lands in the Cache la Poudre Basin are within the primary service area of the Colorado-Big Thompson Project, and were taken into account in the planning investigations. A complete description of the development is presented in the Definite Plan Report, Colorado-Big Thompson Project, February 1954.

Later investigations made by the Bureau of Reclamation on the Cache la Poudre drainage basin are described in the Report on the South Platte River Basin, June 1959.

Early in 1962, investigations to reconnaissance standards were initiated on the multiple-purpose Cache la Poudre Unit which included provisions for hydroelectric power. They were completed less than a year later and the results were presented in a Reconnaissance Report dated February 1963.

PART III--PLAN OF DEVELOPMENT

The potential Idylwilde Dam and Reservoir was the only feature considered for construction in the feasibility investigations. The dam, as designed, would form a reservoir to store and regulate the surplus flows of the Cache la Poudre River primarily for municipal and industrial use. The reservoir could also be used for recreation and for conservation of fish and wildlife. No flood control storage could be justified.

IDYLWILDE DAM AND RESERVOIR

Idylwilde Dam site is located in Section 34, T.9N., R.74W., in Larimer County in north central Colorado, about 45 miles northwest of Fort Collins on State Highway No. 14. The location of the damsite is shown on the General Map, Exhibit 1.

Geology of Damsite

The damsite is located near the downstream terminus of a glacier which formerly occupied the upstream reaches of the river canyon. The containing slopes of this valley are generally precipitous and dissected, and are a combination of granite and schist. The several gulches and stream valleys tributary to the valley are headed by alluvial fans which were formed as the result of the normal erosional processes of the valley slopes being interrupted. The alluvial fans consist of materials which grade from coarse debris to sands and fines. In some instances, these alluvial fans contain deposits suitable for embankment fill material. Underlying the alluvial fans are pervious river depositions consisting of mixtures of gravel and sand.

Bedrock at the damsite is extensively exposed at the left abutment and at the middle and upper portion of the right abutment. The abutments consist of hard gneissic schist that is moderately to severely jointed. In evidence also are numerous intrusions (dikes, sills, and irregular masses) of granitic materials. At the damsite, glacial erosion and removal of weathered bedrock by other natural forces does not appear to be severe. But even so, the weathered zone is probably relatively thin insofar as permitting leakage through the foundation is concerned. No strongly developed faults or shear zones were discovered.

The overburden at the damsite appears to consist principally of relatively pervious sand, gravel, and boulders.

A topographic saddle is upstream from the right abutment. The findings from exploratory work strongly indicate that a tongue of the main glacier that formerly occupied the valley may have entered this area and together with its outwash scoured a deep channel in the saddle.

Dam and Dike Structures

The dam shown on the feasibility design drawing, exhibit 2, would be a zoned earthfill structure with a height above streambed of 313 feet, a crest width of 30 feet, and a length of 1,300 feet at crest elevation 7885.0. A cutoff trench to bedrock backfilled with impervious material would extend across the valley under the dam.

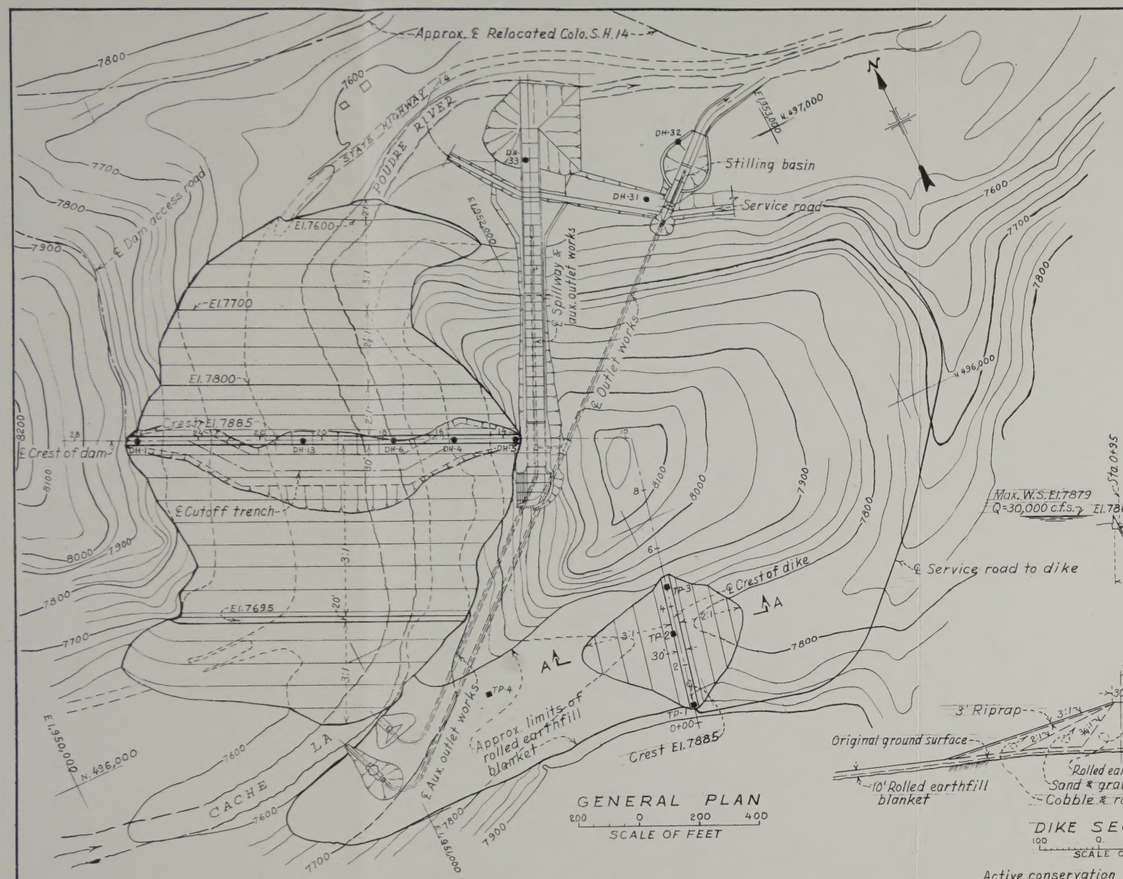
A dike, also shown on exhibit 2, would be located across the saddle upstream from the right abutment of the dam. It would also be a zoned earthfill structure with a height of 78 feet above original ground surface, a crest width of 30 feet, and a length of 450 feet at crest elevation 7885.0. A rolled earthfill blanket with a thickness of 10 feet would be placed under the upstream side of the dike and down into the reservoir to about elevation 7600 to prevent excessive seepage under the dike. The upstream faces of both the dam and dike would be protected by a 3-foot layer of riprap. Total volume of embankment in the dam and dike would be about 7,675,000 cubic yards.

The uncontrolled spillway would consist of a 100-foot-wide channel intake in the right abutment delivering to a covered rectangular box section extending through the crest of the dam and thence into a rectangular chute ending in a stilling basin. The spillway, with a crest elevation of 7860.0, the top of the active conservation pool, was designed with a capacity of 30,000 cubic feet per second with the reservoir water surface at elevation 7879, the top of surcharge capacity. A bridge over the stilling basin is provided for a service road.

The primary outlet works would be located in the right abutment. This complex would be comprised of a glory-hole-type intake, an 11-foot-diameter tunnel leading to a gate chamber housing an emergency gate, and a 90-inch-diameter steel outlet pipe, placed within a 12-foot-diameter horseshoe tunnel and extending from the gate chamber to the control house. The control house would have four high-pressure gates discharging into a circular stilling basin. The capacity of the outlet works would be 2,000 cubic feet per second with the reservoir water surface at elevation 7695, the bottom of the active conservation pool. The intake structure is designed so that a low inlet is available for diversion during construction of the dam. Upon completion of the dam the low inlet would be plugged and the higher glory-hole inlet used.

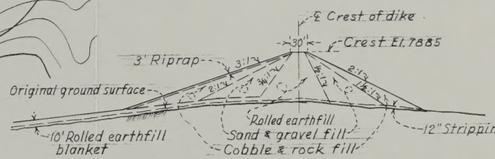
An auxiliary outlet works, also to be located in the right abutment, would be used to make releases during the period required

EXHIBIT 2



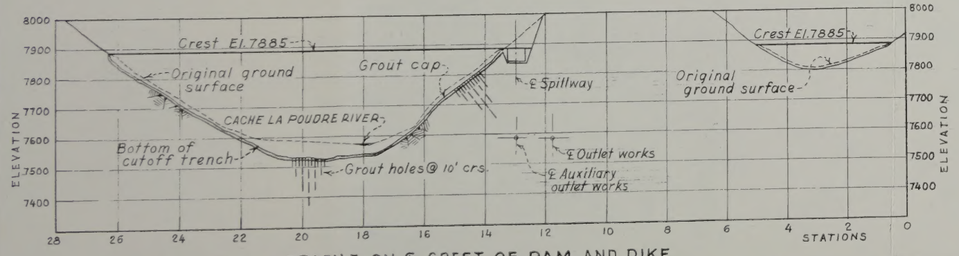
GENERAL PLAN

SCALE OF FEET

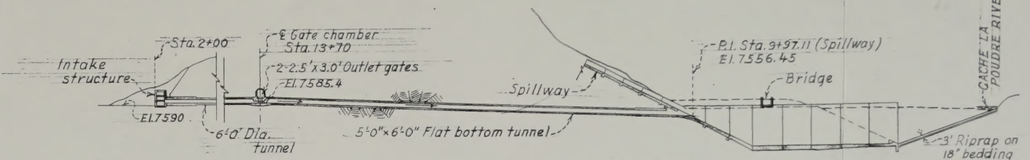


DIKE SECTION A-A

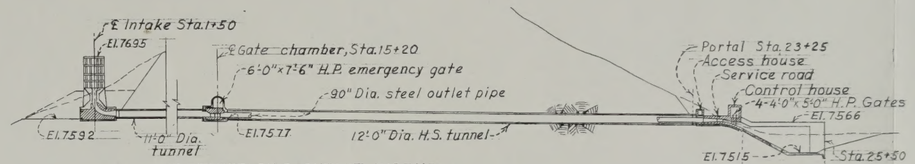
SCALE OF FEET



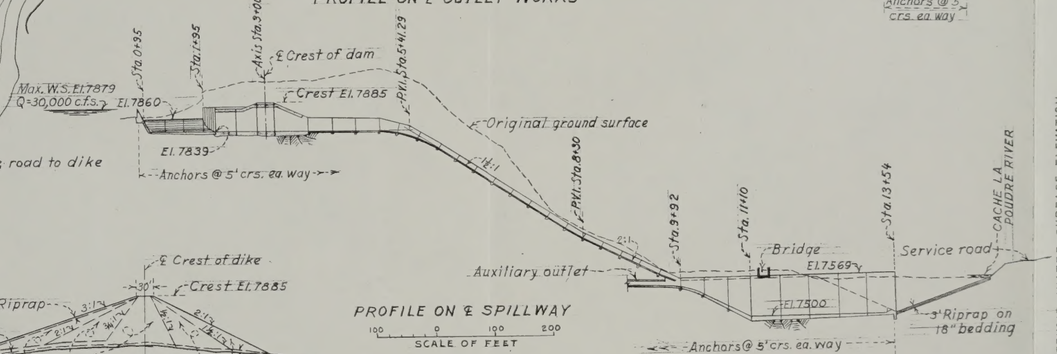
PROFILE ON ℄ CREST OF DAM AND DIKE



PROFILE ON ℄ AUXILIARY OUTLET WORKS

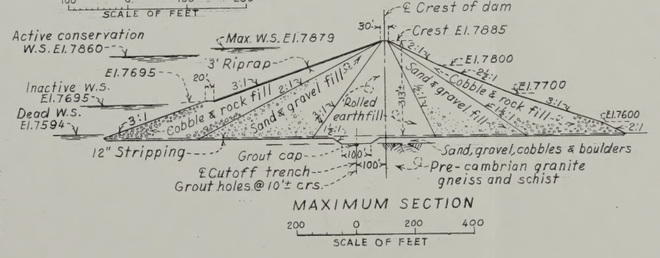


PROFILE ON ℄ OUTLET WORKS



PROFILE ON ℄ SPILLWAY

SCALE OF FEET



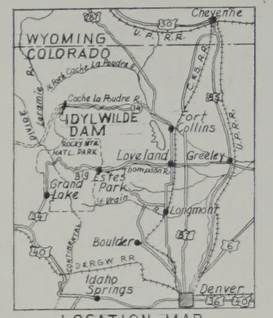
MAXIMUM SECTION

SCALE OF FEET

RESERVOIR CAPACITY ALLOCATIONS

PURPOSE	ELEVATIONS	CAPACITY ACRE-FEET
Active conservation	7695 to 7860	178,500
Inactive	7594 to 7695	14,500
Dead	Streambed to 7594	100
Total reservoir capacity		193,100 *

* Includes no allowance for sediment deposition. A surcharge of 33,000 a.f. (Max. W.S. El. 7879) in combination with a spillway discharge of 30,000 c.f.s. and a river outlet discharge of 3,000 c.f.s. is provided to protect against the inflow design flood which has a peak of 52,000 c.f.s. and a 20 day volume of 206,600 a.f.

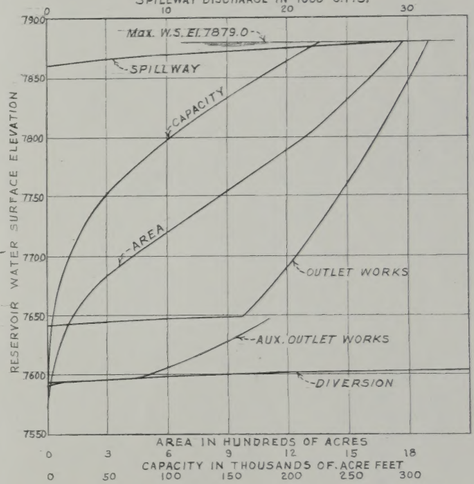


LOCATION MAP

AUXILIARY OUTLET WORKS DISCHARGE IN 100 C.F.S.

DIVERSION & OUTLET WORKS DISCHARGE IN 1000 C.F.S.

SPILLWAY DISCHARGE IN 1000 C.F.S.



AREA-CAPACITY DISCHARGE CURVES

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MISSOURI RIVER BASIN PROJECT
LONGS PEAK DIVISION-CACHE LA POUDRE UNIT-COLO.

IDYLWILDE DAM
FEASIBILITY DESIGN DRAWING

DRAWN C.E.S.	SUBMITTED	R. J. Jansen	
TRACED	RECOMMENDED		
CHECKED C.E.S. 2-20-65	APPROVED		
DENVER, COLORADO APRIL 1, 1965		206-D-1	

GPO 859-016

for plugging of the low inlet on the primary outlet works and during periods when the primary outlet works would be inoperative because of maintenance or repair. The auxiliary outlet would have an intake structure, a 6-foot-diameter tunnel to a gate chamber housing two gates, and a 5-foot by 6-foot flat-bottom tunnel discharging into the spillway stilling basin. The capacity would be 355 cubic feet per second at reservoir water surface elevation 7642. Access to the gate chamber would be by a short tunnel from the gate chamber of the primary outlet works.

SIZE OF RESERVOIR

Idylwilde Reservoir, when filled to the top of the active conservation pool, would back water up the Cache la Poudre River approximately 7 miles. Area-capacity data and storage allocations used for this study are as follows:

Elevation	Purpose	Area (acres)	Allocation (acre-feet)	Total Storage (acre-feet)
7572	(Streambed at dam axis)			0
	Dead and inactive		14,612	
7695		400		14,612
	Conservation		178,536	
7860		1,683		193,148
	Surcharge		32,915	
7879	(max.W.S.)	1,779		226,063
	Freeboard			
7885	(crest of dam)			

Capacity data, rounded to the nearest one hundred acre-feet, are also shown in the table on the Feasibility Design Drawing, exhibit 2.

RELOCATIONS, CLEARING AND FENCING

Existing facilities in the reservoir area which would require relocation are State Highway No. 14, power and telephone lines, and a fish rearing unit owned by the Colorado Department of Game, Fish and Parks.

State Highway No. 14 presently passes through the reservoir area. Its relocation would begin about one-half mile below the damsite and extend for approximately 8.3 miles around the north side of the reservoir Standards for the relocated highway were furnished by the Department of Highways, State of Colorado. Preparation of a detailed cost estimate was started, but was not completed inasmuch as the decision was made to write the concluding report on the basis of estimates obtained with a minimum amount of additional work. Therefore, an estimated cost of

the road relocation was obtained through a cost-per-mile computation using actual costs on similar construction as its basis.

About 8-3/4 miles of 12.5-kv and 7.2-kv transmission lines would be constructed to replace existing REA lines which would be removed from the inundated area. The cost of relocating and replacing rural telephone lines in the reservoir area was furnished by the Mountain States Telephone Company.

A new location for the fish rearing unit was not selected; however, tentative plans were made to relocate it on government owned land. The replacement cost of the facilities was furnished by the Colorado Department of Game, Fish and Parks.

The reservoir area would be cleared of timber in accordance with Bureau of Reclamation standards and criteria. Reservoir rights-of-way would be fenced to the extent needed for proper management and to prevent damage to facilities by livestock.

HOUSING AND OPERATING INSTALLATIONS

A one-family dwelling would be provided at the dam for the reservoir superintendent. A garage and shop would be located near the house.

Facilities would be installed to measure reservoir inflow and outflow.

CONSTRUCTION MATERIALS

Investigations indicated that there is no excess of either impervious or semipervious materials in the reservoir area. Glacial moraines, river terraces, and alluvial fans were investigated for sources, and they range from 0.9 miles to 2.7 miles upstream from the dam axis. Additional materials, should they be required, may be available in limited amounts upstream within a 5-mile haul distance. These sources would be river terraces and alluvial fans in the broader reaches of the valley. Probable sources of additional materials occur about 10 miles downstream from the damsite. These are alluvial deposits of sandy clay containing angular fragments of rocks and boulders and are found at the mouths of larger side hill drainages and along the base of canyon walls.

Materials which are free draining and suitable for concrete aggregates can be obtained from the river flood plains and the terraces bordering them upstream from the damsite. Suitable and adequate supplies of riprap material are available within a 4-mile haul.

RIGHTS OF WAY

Idylwilde Reservoir would be located within the Roosevelt National Forest, which is operated and maintained by the U. S. Forest Service of the Department of Agriculture. State and privately owned lands exist within the forest boundaries.

Rights-of-way would be acquired in accordance with current policy. The requirements would include purchase of 1,100 acres of State-owned land and 440 acres of privately owned land in fee title. In addition, about 2,000 acres of forest land would be required.

The land acquisition proposed would be adequate for construction and operation and maintenance of the Idylwilde Dam and Reservoir and the associated relocations. No additional requirements for recreation and fish and wildlife development are included since work was discontinued before these studies were completed.

PROJECT COSTS

The feasibility design and cost estimate for the Idylwilde Dam was prepared in the Chief Engineer's Office, Bureau of Reclamation. The remainder of the cost estimates were prepared in the Bureau's Regional Office with costs for relocations of telephone lines and the fish rearing unit furnished by the Mountain States Telephone Company and the State of Colorado Department of Game, Fish and Parks, respectively.

Estimates are based on costs prevailing in April 1965. Contingencies of 20 percent were applied on all facilities. Indirect costs amounting to 26 percent of the field costs were applied to all identified properties except General Property for which indirect costs of 23 percent of field costs were applied. These indirect costs include costs for service facilities, investigations and surveys, designs and specifications, supervision of construction, and general expense. General Property costs include funds for the superintendent's residence, office and shop at the Idylwilde Dam; general service equipment; and communications facilities. Costs were not developed and are not included for recreation and fish and wildlife functions.

Estimated costs for the Cache la Poudre Unit follow. All costs shown include contingencies and indirect costs:

Idylwilde Dam and Reservoir	$27,580,000
Lands and rights	$ 1,140,000
Relocations of existing property	3,970,000
Clearing lands	325,000
Structures and improvements	120,000
Dam and dike	(21,885,000)
Dam and dike structure	11,870,000
Spillway	5,230,000
Outlet works	3,730,000
Auxiliary outlet works	1,055,000
Roads and bridges (access and service roads to dam)	140,000
General Property	100,000
Total	$27,680,000

CONSTRUCTION SCHEDULE

A construction schedule was not prepared for the Cache la Poudre Unit.

PART IV--HYDROLOGY

WATER RESOURCES

The water resource analyses included examination of records of available surface and ground water supplies for the period of study 1947 through 1961. Flows available for diversion under water rights held by the cities in the basin were also determined in order to estimate ultimate yields from these rights. The period 1947 through 1961 was chosen as the period on which to base the analyses because this period includes the drouth of the 1950's as well as several years of high flow and because the average annual basin supply for the period closely resembles the long-term average.

Surface Supplies

The total historic surface water supply available to the basin accrues from several sources. Table 1 lists these sources and the average annual supply for the study period, 1947-1961.

The flow at the mouth of the canyon constitutes the gross surface water supply available for irrigation and M&I uses in the basin, while the flow at the mouth of the river near Greeley is essentially unused return flow. However, during some spring snowmelt periods, the flow is so great that the entire volume cannot be controlled by the existing diversion facilities. This uncontrolled water flows from the basin unused, and constitutes the supply which could be regulated in the potential Idylwilde Reservoir for use during periods of shortage.

The time of occurrence and the quantity of these unused flows, which will henceforth be designated as "storable surplus flows" were determined by making a point flow analysis, which is a detailed accounting of monthly flows and diversions. A summary of the results obtained by the point flow analysis and also the estimates of surplus flows made by the Colorado Water Commissioner are shown in table 2.

Although the first water deliveries to the Cache la Poudre Basin were made from the Colorado-Big Thompson Project in 1952, it was not until 1957 that full operation of this project was achieved. Thus, the water supply records for the study period, 1947-1961, are incomplete with respect to the total water supply that is now and will in the future be available to the Cache la Poudre Basin. Therefore, in order to make estimates of future water needs, it was necessary to determine the supply that would have been available had the the Colorado-Big Thompson Project been in full operation throughout the study period.

This analysis was based on a study made by the South Platte River Projects office, Region 7, Bureau of Reclamation, and reflects the adjusted monthly deliveries to each ditch system in the Cache la Poudre Basin for the study period. Table 3 is a summary of this analysis.

Table 1.--Summary of basin surface supplies

(Average Annual)

Source of supply	1,000 Ac.-ft.
"In Basin" Flow at Idylwilde	150.8
Basin imports above Idylwilde	+37.5
Total historic flow at Idylwilde	188.3
Inflow from South Fork Cache la Poudre River	+45.1
Inflow from North Fork Cache la Poudre River	+36.2
Accretions from Idylwilde to mouth of canyon	+30.1 a/
Historic diversions above mouth of canyon gage	-62.8
Total historic flow at mouth of canyon	236.9
Historic Colorado-Big Thompson project deliveries to the Cache la Poudre Basin	+64.3 b/
Net of accretions and depletions from mouth of canyon to Greeley	-228.3 a/
Total historic flow at mouth of Cache la Poudre near Greeley	72.9

a/ Computed difference in the measured flows at the two identified points on the river.

b/ C-BT deliveries commenced in 1952, hence occurred in only 10 of the 15-year period of analysis (1947-1961). This average is based on the 15-year period to achieve consistency between subsequent arithmatic averages and extension totals.

Table 2.--Storable surplus flows

(1,000 ac.-ft.)

Year	Quantities derived from Point flow analysis	Quantities derived from Water Commissioner study
1947	47.2	54.1
1948	0	7.1
1949	63.7	69.0
1950	0	0
1951	2.4	9.7
1952	8.2	16.3
1953	0	0
1954	0	0
1955	0	0
1956	7.5	0
1957	46.7	45.3
1958	62.6	118.6
1959	12.4	19.7
1960	0.3	7.6
1961	100.7	108.7
Total	351.7	452.1
Average	23.4	30.1

Table 3.--Summary of C-BT delivery analysis

(1,000 ac.-ft.)

Year	Historic delivery	Adjusted deliveries*
1947	0	59.9
1948	0	139.4
1949	0	59.9
1950	0	139.4
1951	0	61.6
1952	21.2	57.4
1953	106.9	102.2
1954	157.3	137.7
1955	108.6	135.2
1956	81.0	103.9
1957	80.4	80.4
1958	136.9	136.9
1959	112.6	112.6
1960	100.2	100.2
1961	60.0	60.0
Total	965.1	1486.7
Average (15 yr.)	64.3	99.1

* Assumes full operation of the C-BT project throughout the study period.

Ground-Water Supplies

Ground water is an important source of irrigation water in the lower Cache la Poudre River Basin. A significant part, about 20 percent, of the irrigated area is underlain by aquifers which are capable of supplying irrigation wells. The most rapid development of the ground-water resource occurred during the 8-year period, 1947-1954. Since that period, development has expanded but at a slower rate.

Because the ground-water resource was not uniformly developed throughout the study period, two ground-water studies were prepared as follows: (1) an estimate of pumpage that actually occurred, (2) an estimate of pumpage that would have occurred assuming the 1961 level of development throughout the study period. The latter study represents the pumpage anticipated in the future.

The studies were based on: (a) investigations made by the Geological Survey,[1/] (b) data on power consumption supplied by companies which serve the area, and (c) other related data including water table levels and well tests. Table 4 summarizes the results of the ground-water utilization studies.

Table 4.--Ground-water pumpage

(1,000 acre-feet)

Year	Historic conditions	Assumed conditions*
1947	64.1	109.4
1948	104.9	164.6
1949	85.1	127.6
1950	129.7	174.4
1951	101.6	132.1
1952	133.6	171.1
1953	150.9	183.8
1954	221.2	243.8
1955	191.7	191.7
1956	182.5	182.5
1957	100.1	100.1
1958	121.5	121.5
1959	145.7	145.7
1960	182.8	182.8
1961	108.2	108.2
Total	2023.5	2339.3
Average	134.9	155.9

* Assumes the 1961 level of development for the entire study period.

1/ Lloyd A. Hershey and Paul A. Schneider, Jr., "Ground-Water Investigations in the Lower Cache la Poudre River Basin, Colorado," Geological Survey Water Supply Paper 1669-X,U.S. S.P.O., Washington, 1964.

WATER RIGHTS

The Cache la Poudre River, like most streams of the eastern slopes of Colorado, has been over appropriated, i.e., rights to divert water for direct use and for storage usually exceed the divertible flow. Water would be available for storage in the Idylwilde Reservoir only during periods of very high flow when all rights are satisfied or during the non-irrigation season when storage demands can be met by stream flow accretions below the Idylwilde Dam site. The project would be operated in conformity with Colorado law.

POTENTIAL YIELD OF M&I WATER RIGHTS

The city of Greeley has direct flow rights totaling 12.5 c.f.s. and the City of Fort Collins has rights totaling 19.93 c.f.s., but 4.93 c.f.s. of the latter rights are limited to use during the period April 15 through October 15. The two cities also own rights which permit the importation of water into the basin and rights to obtain water from the Colorado-Big Thompson Project.

Historic diversions made through exercising the rights of the M&I interests are not a measurement of the potential yield of these rights because the demand for water has at times been less than the quantity which could have been diverted. The results of studies for estimating the yields obtainable from these rights are presented in table 5.

Table 5.--Average annual potential yields from existing M&I water rights (acre-feet)

Item	Fort Collins	Greeley
Developed rights		
Direct flow	11,300	8,900
C-BT Shares a/	8,200	10,500
Pleasant Valley Ditch	600	-
Arthur Ditch	2,000	-
North Poudre Irrigation Districts	1,300	-
Bob Creek and Columbine Ditch	-	300
Mountain Reservoirs	-	3,900
Subtotal	23,400	23,600
Undeveloped rights		
Transmountain diversions	-	500
Mountain reservoirs	-	6,300
Total	23,400	30,400

a/ Each share of C-BT rights was judged to yield 0.8 acre-feet of water.

WATER REQUIREMENTS

Agricultural Water Requirements

There are about 32 ditch systems in the Cache la Poudre River Basin serving approximately 240,000 acres of land, based upon an irrigated acreage survey made for the Colorado-Big Thompson Project. As previously indicated, the area receives surface water from the Cache la Poudre River via direct diversions, from releases of storage water from ditch company-owned reservoirs located on the plains and in the mountains of the basin, from transbasin importations, and from the Colorado Big-Thompson Project.

Because of the uncertainty of the need for additional supplemental water for this irrigated area, detailed studies of supplies, requirements, and shortages were not made for each ditch in the basin. However, an agricultural water utilization study was made of the area in its entirety. This study consisted of a monthly comparison of supply with requirement for the period of study.

The irrigation requirements for this study were estimated by a method in which the assumption is made that total water use in an individual year of adequate supply is a measure of requirement. Through inspection of total agricultural water use, the irrigated area was judged to have a full supply during the year 1958. Hence, the water supply used in 1958 is a measure of the total water requirement in that year. For determining the irrigation requirement for other years, the 1958 requirement was used as a base, and adjustments were made to reflect annual variance in weather conditions. These adjustments were based on theoretical consumptive use requirements and effective precipitation.

The annual irrigation supply used in the study included supplies obtained from transbasin importations and the Cache la Poudre Basin surface sources, Colorado-Big Thompson deliveries adjusted to reflect full operation during the study period, and ground-water pumping adjusted to reflect the 1961 level of development. The results of this study are summarized in table 6.

As indicated in table 6, shortages being experienced by agricultural interests in the Cache la Poudre River Basin amount to slightly less than 5 percent of the farm headgate requirement. Conversely, they are receiving approximately 95 percent of their total requirement. It is believed that the small remaining farm irrigation shortages could be virtually eliminated by further improvements in water management practices. The North Poudre Irrigation District, for example, has applied for a Small Reclamation Project Loan to provide funds for the construction of a reregulatory reservoir. This reservoir could essentially eliminate the shortages in this system by permitting more efficient use of the supply now available.

Table 6--Agricultural water utilization

(1000 acre-feet)

	Surface water supplies								Ground water at the farm headgate 3/	Total farm headgate supply	Total farm headgate requirement 4/	Farm headgate shortage		Farm headgate surplus	
	At river headgate 1/					Plains reservoir storage									
	Direct flow, mt. res. & imports	C-BT 2/	Total	Canal losses	At farm headgate	Reservoir releases	Canal losses	At farm headgate				Amount	%	Amount	%
1947	378.4	59.9	438.3	117.8	320.5	97.4	12.4	85.0	109.4	514.9	497.3			17.6	3.5
1948	302.9	139.4	442.3	119.0	323.3	100.5	13.0	87.5	164.6	575.4	626.5	51.1	8.2		
1949	338.9	59.9	398.8	107.6	291.2	90.8	11.5	79.3	127.6	498.1	466.2			31.9	6.8
1950	316.6	139.4	456.0	122.2	333.8	92.6	11.8	80.8	174.4	589.0	514.1			74.9	14.6
1951	407.5	61.6	469.1	122.7	346.4	75.4	9.7	65.7	132.1	544.2	392.4			151.8	38.7
1952	311.5	57.4	368.9	99.1	269.8	87.2	11.2	76.0	171.1	516.9	555.0	38.1	6.9		
1953	291.8	102.2	394.0	107.0	287.0	76.0	9.7	66.3	183.8	537.1	598.9	61.8	10.3		
1954	203.3	137.7	341.0	92.8	248.2	58.1	7.4	50.7	243.8	542.7	644.8	102.1	15.8		
1955	226.6	135.2	361.8	98.1	263.7	43.1	5.5	37.6	191.7	493.0	566.3	73.3	12.9		
1956	310.7	103.9	414.6	111.2	303.4	52.3	6.8	45.5	182.5	531.4	554.1	22.7	4.1		
1957	362.1	80.4	442.5	115.5	327.0	57.3	7.3	50.0	100.1	477.1	451.0			26.1	5.8
1958	273.3	136.9	410.2	112.3	297.9	65.1	8.2	56.9	121.5	476.3	476.3				
1959	320.8	112.6	433.4	116.2	317.2	70.9	9.1	61.8	145.7	524.7	484.3			40.4	8.3
1960	346.7	100.2	446.9	116.1	330.8	81.1	10.4	70.7	182.8	584.3	607.8	23.5	3.9		
1961	273.6	60.0	333.6	88.8	244.8	49.1	6.2	42.9	108.2	395.9	291.2			104.7	35.6
Total	4664.7	1486.7	6151.4	1646.4	4505.0	1096.9	140.2	956.7	2339.3	7801.0	7726.2	372.6		447.4	
Ave.	311.0	99.1	410.1	109.8	300.3	73.1	9.3	63.8	155.9	520.1	515.1	24.8	4.8	29.8	5.8

1/ Supplies which are not stored or are stored outside the service area.
2/ Full operation of the C-BT Project is assumed for the entire study period.
3/ The 1961 level of groundwater development was assumed to be available for the entire study period.
4/ Deliveries made in 1958 were estimated to equal the requirements; requirements for other years were based on the 1958 requirement adjusted for deviations in precipitation and temperature.

Other practices proposed to improve water conservation in the basin include the lining of the canals and combining the operations of the Pleasant Valley and Lake, New Mercer, Larimer County No. 2, and Arthur Ditch systems. These four systems are located in the vicinity of Fort Collins. Field studies conducted by the Bureau of Reclamation during the summer of 1964 led to the conclusion that both proposals--canal linings and combining operations--had merit, but were improvements which could be accomplished to greater advantage by local entities rather than through Federal development.

Municipal and Industrial Requirements

In 1964, projections of future population growth were obtained from the cities of Fort Collins and Greeley. They are presented in table 7.

Table 7.--Population Projections

Year	Fort Collins	Greeley
1960	25,000	26,300
1970	48,000	48,100
1980	80,900	61,600
1990	114,000	77,000
2000	148,000	94,000
2010	192,000	113,000
2020	250,000	135,200
2025	283,000	150,000

Municipal water use in Fort Collins and Greeley was 260 and 292 gallons per capita per day, respectively, for the years 1959 and 1960. As a comparison, in Denver during 1959 municipal use averaged 197 gallons per capita per day 1/. The lower use rate by Denver reflects, among other things, the influence of water meters and a higher population concentration. In projecting the future M&I water requirements for Fort Collins and Greeley, the daily per capita use rate was estimated to be 250 gallons. This estimate reflects anticipated greater population concentrations and improved water management through the use of water meters.

1/ Water consumption data for all three cities obtained from "Public Water Supplies of Colorado, 1959-60", prepared by U. S. Geological Survey in cooperation with Colorado State University Agricultural Experiment Station.

Greeley and Fort Collins have two ways of meeting the resultant increased needs for M&I water from future growth in population. One way is to increase, as needed, the utilization of their existing water rights until these rights are ultimately fully exercised. The second method is through their annexation policies which, in brief, are as follows: the city of Greeley requires that water rights of 0.8 ac.-ft. per acre and Fort Collins 2 ac.-ft. per acre be assigned to each city respectively for each acre of land annexed. The results of studies for estimating future M&I supplies, requirements, and shortages are summarized in tables 8 and 9.

WATER UTILIZATION

An operation study was initiated for the potential Idylwilde Reservoir. This study, insofar as it was completed, was to feasibility standards, and was made on the assumption that the project water would be used for meeting future M&I needs. Included in the operations, were the effects of transferring the rights of some existing mountain reservoirs into Idylwilde and also the effects of transferring on a "space available" basis, the rights of some existing plains reservoirs. Transfer of the mountain reservoirs was proposed to reduce OM&R expenses, and the transfer of the plains reservoir rights was proposed to reduce losses from evaporation and seepage. Work on the operation study was terminated when it was revealed that projected M&I supplies from existing and potential nonfederal sources appeared to be adequate to meet the estimated future needs until 2010 for Fort Collins and 2025 for Greeley.

A mass curve analysis was made to demonstrate that the entire 167,000 acre-feet of storage capability of the Idylwilde site would be required to regulate the total available surplus flow. The inter-relationship of capacity, yield, and cost was shown to be such that the lowest cost per acre-foot of yield could be obtained by constructing a reservoir which utilized the full capacity potential of the site.

River outlet works with 2,000 c.f.s. capacity would be required for meeting maximum requirements to satisfy downstream water rights and an assumed municipal demand on storage.

From these incomplete studies, the regulation of storable surplus flow by the potential Idylwilde Reservoir would yield approximately 20,000 acre-feet of project water annually.

The operation studies indicated also that flows normally stored in some plains reservoirs could be temporarily regulated in Idylwilde, and that storage from several municipal-owned reservoirs located in the mountains could be permanently transferred. Furthermore, the

Table 8--Projected M&I water requirements, supplies, and shortages, Greeley, Colorado

Item	Years 1970	1980	1990	2000	2010	2020	2025
Population	48,100	61,600	77,000	94,000	113,000	135,200	150,000
Requirements:							
Daily per capita, gals.	250	250	250	250	250	250	250
Annual per capita, ac.-ft.	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Total annual, ac.-ft.	13,500	17,200	21,600	26,300	31,600	37,900	42,000
Annual supplies:							
Existing rights, ac.-ft. a/	30,400	30,400	30,400	30,400	30,400	30,400	30,400
Converted rights, ac.-ft. b/	1,400	2,500	3,800	5,300	6,900	8,700	10,000
Total, ac.-ft.	31,800	32,900	34,200	35,700	37,300	39,100	40,400
Annual shortages ac.-ft.	0	0	0	0	0	0	1,600

a/ Derivation shown in table 5.

b/ Existing agricultural rights to be acquired by city under annexation policy.

Table 9.--Projected M&I water requirements, supplies and shortages, Fort Collins, Colorado

Item	Years 1970	1980	1990	2000	2010	2020	2025
Population	48,000	80,900	114,000	148,000	192,000	250,000	283,000
Requirements:							
Daily per capita, gals.	250	250	250	250	250	250	250
Annual per capita, ac.-ft.	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Total annual, ac.-ft.	13,400	22,700	31,900	41,400	53,800	70,000	79,200
Annual supplies:							
Existing rights, ac.-ft. a/	23,400	23,400	23,400	23,400	23,400	23,400	23,400
Converted rights, ac.-ft. b/	3,600	8,800	14,200	19,400	26,400	35,600	40,800
Total, ac.-ft.	27,000	32,200	37,600	42,800	49,800	59,000	64,200
Annual shortages ac.-ft.	0	0	0	0	4,000	11,000	19,000

a/ Derivation shown in table 5.

b/ Existing agricultural rights to be acquired by city under annexation policy.

operations could be adapted to accommodate recreation and fish-wildlife enhancement. Other incidental functions of the reservoir would be the retention of sediment carried by flood flows and possibly some water quality control.

ASSOCIATED HYDROLOGY STUDIES

Reservoir Sedimentation

A program for estimating the sediment discharge into the potential Idylwilde Reservoir was conducted during the spring and summer of 1964. Random samples were taken at the Rustic gaging station and tested for sediment load. Based on the results of these tests and on an average flow of 261 c.f.s. at the station, the 100-year sediment inflow to the Idylwilde Reservoir would be insignificant.

Tailwater Effects

A study was made to determine the effects of the tailwater for normal flows. The conclusion reached was that within the normal flow range no tailwater effects would be experienced.

Streambed Degradation Studies

Field observations indicated that the river channel below the Idylwilde Dam site is well armored since the armoring materials appeared to be much larger than the 3-inch computed minimum requirement. Therefore, no appreciable degradation of the streambed could be expected.

Inflow Design Flood

The inflow design flood study, completed in 1964, was approved by the Chief Engineer for use in the preparation of a feasibility design. The peak flow rate of the inflow design flood is 52,000 c.f.s. and the 20-day volume is 206,600 acre-feet; failure of the upstream Chambers Lake Dam is reflected in these results.

Quality of Water

No analyses were made by the Bureau of Reclamation to indicate the changes in quality of water which might result from operation of the potential unit. Based on water quality analyses of present

surface flows, it was assumed that the water developed by the project would be of suitable quality for municipal and industrial use. The most significant effects anticipated from operation of the potential unit with respect to quality is that the stabilization of streamflows might improve the quality during low flows.

The Public Health Service initiated studies on quality of water within the basin, but this service made no recommendations since its studies were not carried to completion.

If the investigations are reactivated, detailed analyses should be made to determine the effects on quality of water within the service area and also on the quality of the downstream outflow.

PART V--MUNICIPAL AND INDUSTRIAL WATER ALTERNATIVES

Despite quite liberal population projections, tables 8 and 9 indicate that water shortages for Fort Collins and Greeley would not occur until the years 2010 and 2025, respectively. These forecasts are predicated upon continuation of the cities' annexation policies to convert agricultural rights to municipal water supplies as lands are annexed.

With respect to the population of Fort Collins, the historic growth rate from 1940 to 1960 was about 2-3/4 percent annually. Census figures show the city's population at 12,251 in 1940 and 25,027 in 1960. During the interim, however, the Bureau of Census began to count students enrolled at Colorado State University as part of the communities' population. 1/ Adjustment of the 1940 figure to include the students would bring the figure for that year to roughly 14,700 which would then be comparable with the 1960 figure. The annual growth rate cited above reflects the 1940 adjustment. If the annual growth rate of 2-3/4 percent were projected into the future, Fort Collins' population would reach 43,000 in 1980, 74,000 in 2000, and about 127,000 in 2020. All of these figures are substantially less than the projections shown in table 9 and, if used, would result in no estimated water shortages.

Whatever shortages occur in the future, however, conceivably could be met by acquisition of Colorado-Big Thompson Project supplemental water if not by converted rights under the annexation policy. Several Colorado-Big Thompson water transfers in the current market have been consummated at a purchase price of $125 an acre-foot. Assuming an interest rate of as much as 6 percent, the annual cost of acquisition per acre-foot share would be $7.50. The basic project charge of $1.50 per share would bring the annual cost to $9.00. A further adjustment to convert water shares to actual acre-feet ($9.00 ÷ 0.8) would increase the annual acre-foot cost to $11.25 for raw water delivered from the Horsetooth Reservoir.

As compared with that alternative, water provided for municipal and industrial use from Idylwilde Reservoir would be nearly three times as costly. While final recreation and fish and wildlife enhancement benefits have not been established, the maximum non-reimbursable cost allocable to those purposes is limited to 50 percent

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1/ A similar change affects the Greeley historic figures for students at Colorado State College.

of the project cost under Public Law 89-72. Presuming that benefits for those purposes would be adequate to support a maximum allocation, the remaining 50 percent of costs would necessarily be allocable to municipal and industrial supply. A brief analysis follows:

Item	Amount
Cost of Idylwilde Dam and Reservoir	$27,680,000
Estimated interest during construction	1,661,000
Total estimated investment	$29,341,000
50 percent allocable to M&I water	$14,670,500
Annual equivalent (50 yrs.@3.222%)	594,400
Estimated annual OM&R	15,000
Total annual costs - M&I water	$ 609,400
Average annual yield of water ac.-ft.	20,000
Annual cost per acre-foot	$30.47

The cost of over $30 an acre-foot for M&I water from the Idylwilde Reservoir cannot be supported by the cities' alternative costs of acquiring additional Colorado-Big Thompson water supplies. Consequently, the unit would lack justification at this time, even though needs for water would be immediate rather than postponed for many years as indicated by the projections.

PART VI--COOPERATING AGENCY INVESTIGATIONS

Other Federal agencies concerned with water and land resource developments had been advised of the Bureau of Reclamation's plans for making feasibility studies of the potential unit. Accordingly, each interested agency became actively engaged in developing plans for including its respective function. When the decision was made to terminate the feasibility investigations, the cooperating agencies were so advised.

A study of the reservoir site was made by the Bureau of Mines for mineral resources. According to that Bureau's report of January 1964, entitled "Mineral Resources at Idylwilde Reservoir Site," mineral production in the general project area has been virtually nonexistent. The only record of metal mining activity within the site is the abandoned Home district mine which was located three-fourths of a mile upstream from the damsite. No production has been reported. A small sand and gravel pit yielding substandard materials was being operated 2 miles upstream from the damsite. The gravel was being used for road material.

PART VII--SUPPORTING DATA

The supporting data for this report are on file in the Regional Office, Bureau of Reclamation, Denver, Colorado. On file are considerable quantities of data concerning the hydrologic and engineering investigations. In particular, is a detailed presentation entitled "Geological Investigations" included as exhibit A in the data compiled for making the design and cost estimate of the Idylwilde Dam and Reservoir. This presentation is dated January 1965 and includes a description and the location of fill materials for the dam.

Included with the supporting data are the details of sediment surveys which were made on 18 of the existing irrigation reservoirs. All of the reservoirs surveyed are located in the plains section of the basin, and are owned and operated by private irrigation companies. The purpose of these surveys was to provide a basis for estimating the amount of water which could be conserved by transferring the storage to Idylwilde Reservoir. Conservation of water would have been effected through reduction of losses from evaporation, phreatophytic consumption, and operational wastes.

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